Assignment Answers
DAY 3 Thursday 6/9

Assignment - Ionosphere-Thermosphere A

1. What are the different layers of the ionosphere? what is the difference between dayside and nightside?

Daytime:
D 50-90 km
E 90-140 km
F1 140-210 km
F2 >210 km

Nighttime:
F and Sporadic E

ionization of D-layer

2. Two major contributing factors to the I-T system. What are the forces from above? what are the forces coming from below?

above: solar EUV inputs, electrodynamic and particle coupling with solar wind/magnetosphere
below: Tide and gravity waves, coupling with terrestrial weather

3. Which species has the largest density in the ionosphere? neutrals

4. Name a few space weather phenomena in the ionosphere and their cause.

spacecraft charging - Auroral particles
satellite drag — neutrals
scintillation - high latitude due to auroral and equatorial region bubbles
radio blackout — solar flare
polar cap absorption — solar energetic particles
communication problems - solar flare, geomagnetic disturbances, scintillation, etc.

5. What type of space weather phenomena can cause communication and navigation problems?

a. SID
b. Solar energetic particles
c. geomagnetic storms

6. What is scintillation? Why do we care?

can be found in the lecture

7. What are the ionospheric scintillation indices?

directly from the lecture

Assignment - Ionosphere-Thermosphere B

1. What is satellite drag? Why do we care?
Track and identify active payloads and debris
Collision avoidance and re-entry prediction
Attitude Dynamics
Constellation control
“Drag Make-Up” maneuvers to keep satellite in control box
Delayed acquisition of SATCOM links for commanding /data transmission
Mission design and lifetime

Assignment - WSA-ENLIL Cone modeling

1. What are the principles of the CME cone modeling?

The CME cone model is based on observational evidence that CME has more or less constant angular diameter in corona, being confined by the external magnetic field, so that CME does not expand in latitude in the lower corona, but expands in interplanetary space because of the weaker external field. The assumptions are the following: 1) CME propagates with nearly constant angular width in a radial direction; 2) CME bulk velocity is radial and the expansion is isotropic

2. Describe the coronagraphs and the different methods of deriving CME parameters:

CME and its motion in the interplanetary space can be observed in the coronagraph images. Coronagraphs create an artificial eclipse of the Sun. Eclipses allow corona to be better viewed. Occulting disk blocks the bright sun so we can observe coronal features. Xie et al, 2004, developed an analytical method of defining Cone Model CME parameters for Halo CMEs based on series of coronograph images. A. Pulkkinen , 20010 developed automatic method of defining Cone Model CME parameters for Halo CMEs. Another method to derive Cone model parameters is triangulation method.

3. What are CME parameters used for the WSA-ENLIL Cone model?

CME parameters, input to WSA-ENLIL Cone Model, are:
1- start time of CME at 21.5 Rs (inner boundary of the ENLIL model)
2- Cone axis latitude
3- Cone axis longitude
5- Cone Radius – half angle of the cone angular width
6- Radial Velocity

4. Describe the components of the WSA-ENLIL model:

1) Wang-Sheeley-Arge model (WSA, AFRL). The input to the WSA is daily magnetograms of the solar surface, that describe the magnetic field of the photosphere. WSA uses empirical formula for the solar wind speed and the magnetic field at 21.5 Rs - the input boundary to the ENLIL model.

2) ENLIL (ENLIL – Sumerian for God of Winds and Storms, Dusan Odstrcil, GMU & GSFC). Input to ENLIL for radial components is coronal maps of Br and Vr updated 4 times a day based on WSA model (for the inputs of toroidal components at the inner boundary Parker spiral model is used). ENLIL's inner radial boundary is located beyond the sonic point, so the solar wind flow is supersonic in ENLIL. Solves ideal fully ionized plasma MHD equations
in 3D. Computes a time evolution of the global solar wind for the inner heliosphere

5. What is the output of the WSA-ENLIL cone model?

3D distribution of the the solar wind parameters (density, bulk velocity, temperature) at spacecrafts and planets and topology and strength of IMF.

6. What are the limitations of the WSA-ENLIL cone model?

The model does not take into account the realistic complex magnetic field structure of the CME magnetic cloud. CME, as a plasma cloud, has a uniform velocity.

What are the CME impact parameters?

1. CME shock arrival – a sharp jump in the dynamic pressure.
2. Duration of the disturbance – duration of the dynamic pressure hump.
3. In case of the Earth we estimate also the degree of compressing of the magnetosphere: when the CME mass reaches the magnetosphere it pushes it inward and the magnetic field of the Earth is stressed like a spring to stop the CME motion.
4. In case of the Earth we estimate also Kp index – a measure of the disturbance of of the Earth's magnetosphere, derived from ground based magnetic field measurements. We use Pat Newel's empirical formula for that.

Assignment - Space Weather Impacts on Satellites

What are Single-Event Effects (SEEs) and their source?

SEE - current generated by ion passing through the sensitive volume of a biased electronic device changes the device operating state
source - Galactic Cosmic Rays, Solar Particle Events (flare/CME), Trapped Protons in the inner belt (1 – 3 RE), High energy neutrons

What is the source for surface charging?

Ring current and aurora population in the energy range of few eV to tens keV (slide 22)

What is the source for deep dielectric charging?

high energy electrons (> 300 keV)